FORM PTO-1390 (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER: 450104-03688

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO (If known see 37 C.F.R. 1.5): 10/019809

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/02739	27 April 2000	27 April 1999

TITLE OF INVENTION: **METHOD OF MANUFACTURING A MICROMACHINE**

APPLICANT(S) FOR DO/EO/US: **Masayoshi ESASHI, Takao MURAKOSHI, Shigeru NAKAMURA and Nobuo TAKEDA**

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired
   d. ☒ have not been made and will not be made.
8. ☐ A English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 – 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

    PCT/RO/101, PCT/ISA/210, PCT/IPEA/401
    9 sheets of drawings, 1 page of Abstract

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U S APPLICATION NO (if known, see 37 C F R 1 50)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NO
10/019809	PCT/JP00/02739	450104-03688

21. ☒ The following fees are submitted	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37CFR 1 445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO ... $1040 00	
International preliminary examination fee (37 C F R 1 482) not paid to USPTO but International Search Report prepared by the EPO or JPO ... $890 00	
International preliminary examination fee (37 CFR 1 482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO ... $740 00	
International preliminary examination fee paid to USPTO (37 CFR 1 482) but all claims did not satisfy provisions of PCT Article 33(1)-(4 ... $710.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ... $100 00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total Claims	12 - 20 =	0	x $18.00	$ 0.00
Independent Claims	3 - 3 =	0	x $84.00	$ 0.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $280.00	$

TOTAL OF ABOVE CALCULATIONS =	$ 890.00
☐ Applicant claims small entity status. See 37 C.F.R. 1.27. The fees indicated above are reduced by ½. +	$
SUBTOTAL =	$
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).	$
TOTAL NATIONAL FEE =	$ 890.00
Fee for recording the enclosed assignments (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3.31) **$40.00** per property +	$ 0.00
TOTAL FEES ENCLOSED =	$ 890.00
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b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

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NAME

25,506
REGISTRATION NUMBER

Dated: October 25, 2001

Attorney Docket No. 450104-03688

New Patent Application filed **October 25, 2001**, entitled:

METHOD OF MANUFACTURING A MICROMACHINE

corresponding to PCT Application No. PCT/JP00/02739

filed April 27, 2000

Express Mail No.: EL 819168659 US

Date of Deposit: October 25, 2001

I hereby certify that this application and the accompanying papers are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to:

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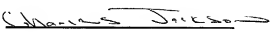

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DESCRIPTION

METHOD OF MANUFACTURING A MICROMACHINE

TECHNICAL FIELD

The present invention relates to a method of manufacturing a micromachine or spherical sensor type measurement device comprising a minute spherical sensor part and peripheral part or peripheral electrodes surrounding it. More specifically it relates to a method of manufacturing a minute sphere and minute electrode bodies with diameters of a few millimeters or less.

BACkGROUND ART

Methods and devices have been known whereby external forces and acceleration can be detected by causing a minute sphere to float electrostatically or magnetically without coming into contact with its periphery. Such devices typically comprise a minute sphere, a device for generating an electric field or a magnetic field which causes the minute sphere to float, and a pick-up for detecting changes in displacement. It should be added that the floating sphere is sometimes rotated at high speed.

The device for generating an electric field or a magnetic field and pick-up for detecting changes in displacement typically comprise a plurality of electrodes, which are located in close proximity to the sphere.

The practice hitherto has been for the minute sphere and peripheral electrodes to be manufactured separately and then assembled. Accordingly, no suitable method has been known for manufacturing the sphere and peripheral electrodes simultaneously

and accurately, and positioning them correctly in close proximity to each other.

In the field of manufacturing conductor devices, numerous methods and techniques are known for the stratified formation of detailed circuit patterns. These comprise lithography, etching, chemical vapor deposition (CVD) and electron beam exposure. However, although these methods permit the manufacture of flat substrates or chips, they cannot be applied to the formation of minute spherical bodies and minute electrodes positioned in close proximity around them.

It is therefore an object of the present invention to provide a method whereby minute spherical bodies and minute electrodes positioned in close proximity around them can be manufactured accurately and simply.

It is an object of the present invention to provide a method of manufacturing minute spherical bodies and minute spherical surfaces surrounding them whereon electrodes are formed.

DISCLOSURE OF THE INVENTION

The method of manufacturing a micromachine comprising a sphere and a peripheral part surrounding it according to the present invention comprises formation of a sacrificial film so as to cover the sphere, formation of a structural film with the object of forming a peripheral part on the sacrificial film, formation of an aperture in the structural film so as to expose the sacrificial film, and removal of the sacrificial film.

Thus it is possible to manufacture a sphere and electrodes

located in close proximity thereto simultaneously and accurately. Particularly, it is possible to manufacture a minute sphere and a minute electrode as well.

The method of manufacturing a micromachine according to the present invention comprises forming the sacrificial film so as to cover completely the whole surface of the sphere, the sphere being completely separated from the peripheral part by virtue of the removal of the sacrificial film. It also comprises forming an aperture in the sacrificial film so as to expose the sphere, and forming the structural film so as to connect with the exposed sphere, the sphere being supported from the peripheral part with the aid of columns. Alternatively, the sphere is supported from the peripheral part with the aid of columns by virtue of the fact that the sacrificial film is partially removed.

The method of manufacturing a sphere and an electrode body according to the present invention comprises a process of forming a sacrificial film on the surface of a sphere, a process of forming a plurality of electrode patterns comprising a conductor film on the sacrificial film, a process of forming an insulator film so as to bridge the electrode patterns, and a process of removing the sacrificial film.

In addition, the method of manufacturing a sphere and an electrode body according to the present invention comprises forming a second sacrificial film so as to cover the sacrificial film on which the electrode patterns are formed, forming groove patterns on the second sacrificial film so as to expose the electrode patterns, and forming an insulator film so as to connect the plurality of

exposed electrode patterns, the method of removing the sacrificial film comprising removal of the two sacrificial films.

In the method of manufacturing a sphere and an electrode body according to the present invention, the sphere is composed of monocrystalline or polycrystalline silicon, the first and second sacrificial films are silicon dioxide films, the conductor film is a polycrystalline silicon film, and the insulator film is a silicon nitride or high-resistance polycrystalline silicon film.

The method of manufacturing a sphere and an electrode body according to the present invention comprises forming the sacrificial films so as to cover completely the whole surface of the sphere, the sphere being completely separated from the electrodes by virtue of the removal of the sacrificial films.

The spherical sensor type measuring device according to the present invention comprises a sphere which functions as a sensor, a peripheral part having a spherically shaped inner surface which encloses the sphere, and a plurality of electrodes formed on the spherically shaped inner surface.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a cross-sectional view illustrating the structure of the floating spherical type measuring device according to the present invention;

FIGS. 2A and 2B are diagrams illustrating the external appearance of the floating spherical type measuring device according to the present invention;

FIG. 3 is a diagram illustrating the electrical circuit

pattern of the floating spherical type measuring device according to the present invention;

FIGS. 4A and 4B are explanatory diagrams for the purpose of explaining the method of manufacture of the floating spherical type measuring device according to the present invention;

FIGS. 5A, 5B and 5C are explanatory diagrams for the purpose of explaining the method of manufacture of the floating spherical type measuring device according to the present invention;

FIGS. 6A, 6B and 6C are explanatory diagrams for explaining the method of manufacture of the floating spherical type measuring device according to the present invention;

FIG. 7 is a cross-sectional view illustrating the structure of the non-floating spherical type measuring device according to the present invention; and

FIGS. 8A, 8B and 8C are explanatory diagrams for explaining the method of manufacture of the non-floating spherical type measuring device illustrated in FIG. 7 according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Before the method of manufacture according to the present invention is explained, the structure of a floating spherical type measuring device manufactured according to that method will be described with the aid of FIGS. 1 and 2. Examples of floating spherical type measuring device comprise acceleration gauges and gyros and the like. As may be seen from FIG. 1, the device of this example comprises a spherical mass part 10 and a spherical

peripheral casing 100 surrounding it.

The external diameter of the mass part 10 is slightly smaller than the internal diameter of the spherical internal surface of the casing 100. When the mass part 10 is caused to float electrostatically, magnetically or by another suitable method, a gap 11 is formed around the mass part 10. This gap 11 is a sealed space, and may form a vacuum. It may also be filled with a suitable inert gas. The diameter of the mass part 10 is a few millimeters and less, and the thickness of the gap 11 may be a few microns.

On the spherical inner surface of the casing 100 are formed six electrodes 101, 102, 103, 104, 105, 106 (only electrodes 101, 102, 105, 106 are illustrated in FIG. 1), with a shield electrode 107 arranged therebetween. The six electrodes 101-106 may be used, for instance, as a power source or for control purposes, while the shield electrode 107 may be used as an earth. The six electrodes 101-106 and shield electrode 107 are separated from one another by a narrow groove, and are connected by bridges 130 located on their outer surfaces.

The seven electrodes 101-106, 107 are formed with conductors, the bridges 130 with insulators. A protective film 132 for the insulators is formed on the outer surface of the casing 100. To each of the seven electrodes 101-106, 107 are connected terminals 111-116, 117 (cf. FIG. 2B), which will be described below.

Explanation will be given referring to FIG. 2. An origin O is depicted in the center of the mass part 100, while X_1-X_2 axis and Y_1-Y_2 axis are taken on the horizontal plane. The vertical axis is represented as Z_1-Z_2. FIG. 2A views the device along the Y_1 axis

direction, FIG. 2B along the $Z2_2$ axis direction. FIG. 1 is a cross-sectional view cut along the vertical face X-Z plane, and FIG. 3 is an external view of the device of this example.

As the broken lines show, the six electrodes 101-106 are circular in shape, and are each arranged along three orthogonal axes. The portion remaining from the six electrodes 101-106 is a shield electrode 107.

The terminals 111-116, 117 are located in positions corresponding to the electrodes 101-106, 107, each electrode and the corresponding terminal being connected electrically. Electrical circuit patterns 121-126, 127 (cf. FIG. 2B) extend from the terminals 111-116, 117.

As may be seen from FIG. 2B, the tips of the electrical circuit patterns 121-126, 127 converge on the under side of the outer surface of the casing 100. The tips of the electrical circuit patterns 121-126, 127 are arranged, for instance, around a single circle as illustrated in the drawing. In this manner the six electrodes 101-106 and the shield electrode 107 are able to connect with an external device (not illustrated in the drawings) with an electrode terminal part located in the same manner along a single circle.

Although not illustrated in detail in the present example each of the 6 electrodes 101 ~ 106 comprises a pair of electrode parts and therefore, six pairs of terminals 111-116 connected to the electrodes 101-106 each comprise a pair of terminals . This means that there are two electrical circuit patterns extending from these terminals for each electrode. It should be noted that there is only

one terminal 117 connected to the shield electrode 107, and only one electrical circuit pattern extends therefrom.

There follows, with reference to FIGS. 4, 5 and 6, a description of the method of manufacture according to the present invention. First, as FIG. 4A shows, a sphere 10 is prepared from silicon Si, preferably monocrystalline silicon Si. This forms the mass part 10. Next, as may be seen from FIG. 4B, a first insulator film is formed on the surface of the sphere 10, for instance, in the shape of a silicon dioxide SiO_2 film 12. This may be achieved with the aid of chemical vapor deposition (CVD).

In the next process the electrode patterns are formed from a conductor film. First, as may be seen in FIG. 4C, a conductor film comprising, for instance, a polycrystalline silicon Si film 14 is formed so as to cover the first insulator film 12 completely. Next electrode pattern grooves 15 are formed on a polycrystalline silicon Si film 14 by etching. These electrode pattern grooves 15 are formed in the shape of six narrow rings corresponding to the shape of the six electrodes 101-106. In this manner electrode patterns are formed inside the 6 ring shaped grooves with shield electrode patterns formed on the outside thereof.

It should be added that various other shapes of electrode pattern may be considered in addition to the circular patterns of this example.

Next, as FIG. 5A shows, a second insulator film 16 is formed of silicon dioxide SiO_2. This may be achieved with the aid of chemical vapor deposition (CVD). Thus the electrode pattern grooves 15 formed in the process illustrated in FIG. 4C are filled with

silicon dioxide SiO_2, so that the first silicon dioxide film 12 and second silicon dioxide film 16 are connected via the electrode pattern grooves 15.

The first and second silicon dioxide insulator films 12, 16 are later removed, and are therefore known as dummy or sacrificial films.

In the process which follows, an insulator bridge is formed in order to connect the electrode and shield electrode patterns. First, as may be seen from FIG. 5B, bridging pattern grooves 17 are etched into the second silicon dioxide film 16. The bridging grooves 17 are created in suitable numbers on either side of the electrode pattern grooves 15, which form the boundary between the six electrode patterns and the shield electrode pattern. In parts of the bridge pattern grooves 17, the conductor film or polycrystalline silicon Si film 14 is exposed.

Next, as FIG. 5C shows, a silicon nitride Si_3N_4 insulator film 18 is formed. This silicon nitride Si_3N_4 film 18 is formed along the electrode pattern grooves 15 so as to cover the bridge pattern grooves 17 which have been formed on the second silicon dioxide film 16. In this manner the exposed electrode and shield electrode patterns are connected by means of the silicon nitride Si_3N_4.

Next, as may be seen in FIG. 6A, the two sacrificial films, which is to say the first and second silicon dioxide films 12, 16 are removed. It goes without saying that the silicon dioxide which fills the electrode pattern grooves 15 formed in the polycrystalline silicon film 14 is also removed. Thus, the monocrystalline silicon sphere 10 is separated from the periphery, and the mass part 10 is

formed.

Removal of the silicon dioxide is effected by the use of a suitable solution in which silicon dioxide dissolves, but which does not dissolve the monocrystalline silicon sphere 10, polycrystalline silicon film 14 or silicon nitride film 18. This solution first dissolves the second silicon dioxide film 16, then the silicon dioxide which fills the electrode pattern grooves 15. Finally, it dissolves the first silicon dioxide film 12 via the grooves 15.

Next, a protective film is formed from the insulator film. As FIG. 6B shows, a third silicon dioxide film 20 is formed so as to cover the whole casing 100. This may again be achieved with the aid of chemical vapor deposition (CVD). By virtue of the fact that a protective film is formed in this manner, the gap 11 formed on the outside of the mass part 10 becomes a shield space. As has been stated above, this shield space may be a vacuum, or it may be filled with a suitable inert gas. Furthermore, terminal pattern grooves 21 are formed on this third silicon dioxide film 20 in positions corresponding to the six electrode patterns and the shield electrode pattern.

Finally, a wiring pattern from a thin metal film is formed on top of the third silicon dioxide film 20, thus forming terminals 22 as shown in FIG. 6C. The terminals 22 are formed so as to be each connected to the six electrode patterns and the shield electrode pattern. It should be added that although not illustrated in FIG. 6C an electrical circuit pattern (cf. FIG. 2) is also formed extending from the terminal 22.

There now follows, with reference to FIG. 7, a description

of another example of the present invention. This example comprises a sphere 10 and a peripheral casing 100 in the shape of a spherical surface surrounding it. The mass part 10 is supported on the peripheral casing 100 with the aid of columns 110. As the drawing shows, the columns 110 may consist of a pair of columns 110 located along the Z axis, which is to say at the north and south poles. In this example there is no need, as in the case of the floating spherical type measuring device illustrated in FIG. 1, to provide a device for generating electrostatic or magnetic force in order to float the mass part 10.

The method of manufacturing the device illustrated in FIG. 7 will be described with reference to FIG. 8. First, as FIG. 8A shows, a sphere 10 is prepared from silicon Si, preferably monocrystalline silicon Si. This forms the mass part 10. Next, as may be seen from FIG. 8B, a first insulator film is formed on the surface of the sphere 10 in the shape, for instance, of a silicon dioxide SiO_2 film 12. This may be achieved with the aid of chemical vapor deposition (CVD). Next, the first insulator film 12 is etched to form grooves 13 in the positions where the columns 110 are to be formed, thus exposing the sphere 10.

The process thereafter is similar to that adopted in manufacturing the device illustrated in FIG. 1. In the next process the electrode patterns are formed from a conductor film. First, as may be seen in FIG. 8C, a conductor film comprising, for instance, a polycrystalline silicon Si film 14 is formed so as to cover the first insulator film 12 completely. As a result of this process the grooves 13 in the first insulator film 12 are filled with

polycrystalline silicon Si film. What follows is the same as in the method of manufacturing described above.

Next, electrode pattern grooves 15 are etched on to the polycrystalline silicon Si film 14. These electrode pattern grooves 15 are formed in the shape of six narrow rings corresponding to the shape of the six electrodes 101-106. Thus, the electrode patterns are formed on the inside of the six ring-shaped grooves, while the shield electrode pattern in formed on the outside.

After that, the method which has been described with reference to Figs. 5 and 6 applies without modification. As FIG. 5A shows, a second insulator film 16 is formed of silicon dioxide SiO_2, following which bridging pattern grooves 17 are etched into the second silicon dioxide film 16 as shown in FIG. 5B. Then, as FIG. 5C shows, a silicon nitride Si_3N_4 insulator film 18 is formed.

Next, as may be seen in FIG. 6A, the two sacrificial films, which is to say the first and second silicon dioxide films 12, 16 are removed. Thus, the monocrystalline silicon sphere 10 is separated from the periphery except for the columns 110, and the mass part 10 is formed.

As FIG. 6B shows, a third silicon dioxide film 20 is formed, upon which a metal film wiring pattern is formed as shown in FIG. 6C. In this manner the terminals 22 are formed.

In the above example, the columns 110 are formed in the process in which the conductor or polycrystalline silicon Si film 14 is formed. Consequently, the columns 110 consist of conductors like the electrodes 101-106, 107. However, it is also possible to form the columns 110 out of the first insulator or silicon dioxide SiO_2

film.

The above is a detailed description of embodiments of the present invention, but it will easily be understood by persons versed in this field that the present invention is not limited to these embodiments and may employ various other configurations without departing from the gist thereof.

The present invention has the advantage of allowing the sphere and the peripheral electrodes to be manufactured simultaneously.

The present invention has the advantage of allowing the gap between the sphere and the peripheral electrodes to be formed accurately and simply.

The present invention has the advantage of allowing the sphere and the peripheral electrodes to be manufactured accurately even if they are very small in dimension.

DESCRIPTION OF REFERENTIAL NUMERALS

10 ... Sphere, mass part

11 ... Gap

12 ... Silicon dioxide film (sacrificial film)

14 ... Polycrystalline silicon film (conductor film, electrode pattern)

15 ... Electrode pattern groove

16 ... Silicon dioxide film (sacrificial film)

17 ... Bridge pattern groove

18 ... Silicon nitride film (insulator film)

20 ... Silicon dioxide film (protective film)

21 ... Terminal pattern groove

22 ... Metal film (terminal pattern)

100 ... Casing

101, 102, 103, 104, 105, 106 ... Electrodes

107 ... Shield electrode

111, 112, 113, 114, 115, 116, 117 ... Terminals

121, 122, 123, 124, 125, 126, 127 ... Electric circuit pattern

130 ... Bridge

132 ... Protective film

CLAIMS

1. A method of manufacturing a micromachine including a sphere and a peripheral part, comprising:

formation of a sacrificial film so as to cover the sphere;

formation of a structural film with the object of forming a peripheral part on said sacrificial film;

formation of an aperture in the structural film so as to expose said sacrificial film; and

removal of the sacrificial film.

2. The method of manufacturing a micromachine according to Claim 1, characterized by

forming said sacrificial film so as to cover completely the whole surface of said sphere, and

the sphere being completely separated from said peripheral part by virtue of the removal of the sacrificial films.

3. The method of manufacturing a micromachine according to Claim 1, characterized by comprising:

forming an aperture in said sacrificial film so as to expose said sphere; and

forming said structural film so as to connect it with said exposed sphere,

the sphere being supported from the peripheral part with the aid of columns by virtue of the removal of said sacrificial film.

4. The method of manufacturing a micromachine according to Claim 1, characterized in that

said sphere is supported from said peripheral part with the

aid of columns by virtue of the fact that said sacrificial film is partially removed.

5. A method of manufacturing a sphere and an electrode body, comprising:

a process of forming a sacrificial film on the surface of a sphere;

a process of forming a plurality of electrode patterns including a conductor film on the sacrificial film;

a process of forming an insulator film so as to bridge the electrode patterns; and

a process of removing the sacrificial film.

6. The method of manufacturing a sphere and an electrode body according to Claim 5, characterized in that the process of forming said insulator film comprises:

forming a second sacrificial film so as to cover said sacrificial film on which said electrode patterns are formed;

forming groove patterns on the second sacrificial film so as to expose said electrode patterns; and

forming an insulator film so as to connect said plurality of exposed electrode patterns,

the method of removing said sacrificial film comprising removal of said second sacrificial film.

7. The method of manufacturing a sphere and an electrode body according to Claim 5, characterized in that

said sphere is composed of monocrystalline or polycrystalline silicon.

8. The method of manufacturing a sphere and an electrode

body according to Claim 5, characterized in that

said first and second sacrificial films are silicon dioxide films.

9. The method of manufacturing a sphere and an electrode body according to Claim 5, characterized in that

said conductor film is a polycrystalline silicon film.

10. The method of manufacturing a sphere and an electrode body according to Claim 5, characterized in that

said insulator film is a silicon nitride or high-resistance polycrystalline silicon film.

11. The method of manufacturing a sphere and an electrode body according to Claim 5, characterized by comprising:

forming the sacrificial films so as to cover completely the whole surface of the sphere,

the sphere being completely separated from the electrodes by virtue of the removal of the sacrificial films.

12. A spherical sensor-type measuring device having a sphere which functions as a sensor, a peripheral part having a spherically shaped inner surface which encloses the sphere, and a plurality of electrodes formed on the spherically shaped inner surface.

ABSTRACT OF THE DISCLOSURE

It is an object of the present invention to provide a method of manufacturing a floating spherical type measuring device comprising a sphere which is capable of floating, and electrodes surrounding it. The method of manufacturing a measuring device according to the present invention comprises forming a first sacrificial film on the surface of the sphere, forming electrode patterns from a conductor film upon the first sacrificial film, forming a second sacrificial film so as to cover the first sacrificial film on which the electrode patterns have been formed, exposing the electrode patterns by forming groove patterns on the second sacrificial film, forming an insulator film so as to connect a plurality of exposed electrode patterns, and removing the first and second sacrificial films.

FIG. 1

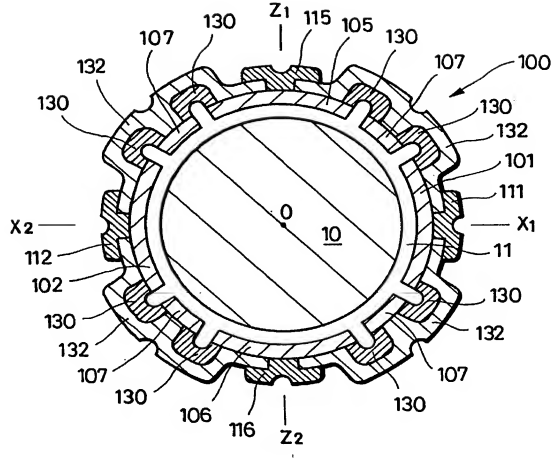
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FIG. 2A

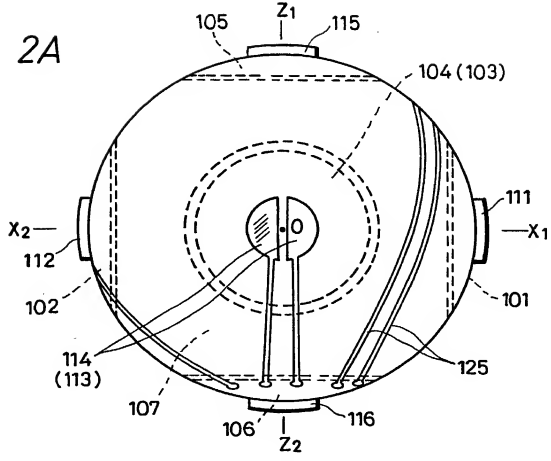
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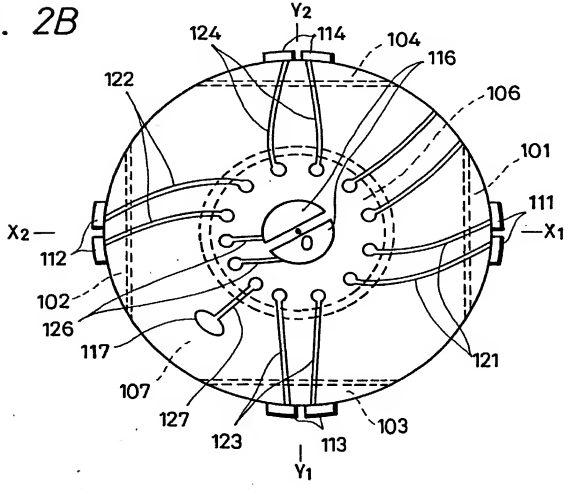
FIG. 2B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107
127
123
113
103
Y1

FIG. 3

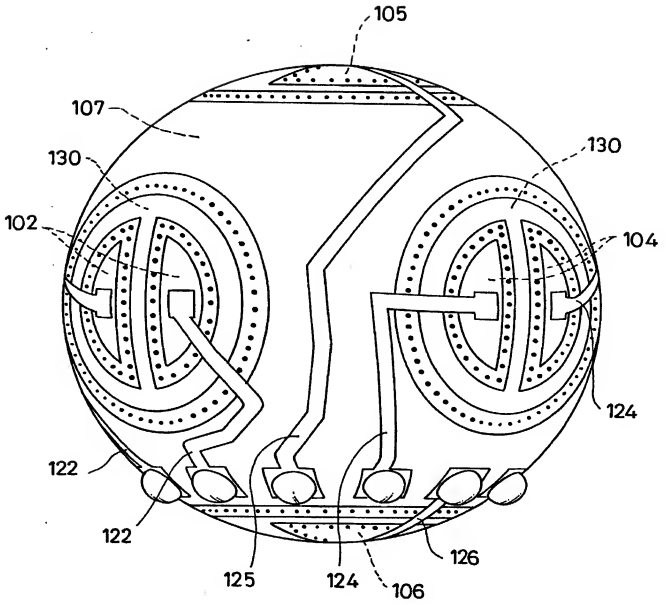


FIG. 4A

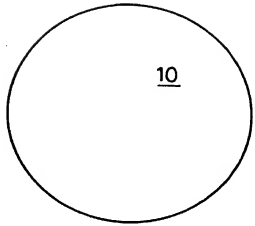


FIG. 4B

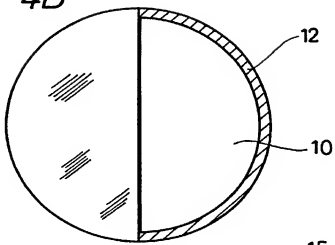


FIG. 4C

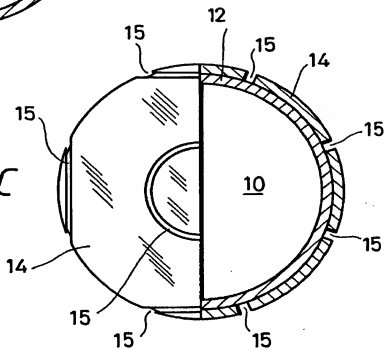


FIG. 5A

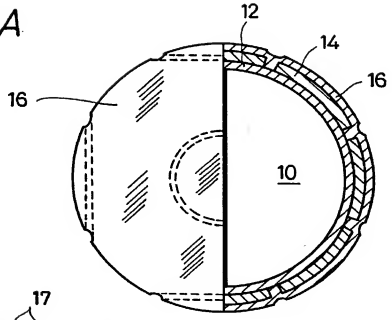


FIG. 5B

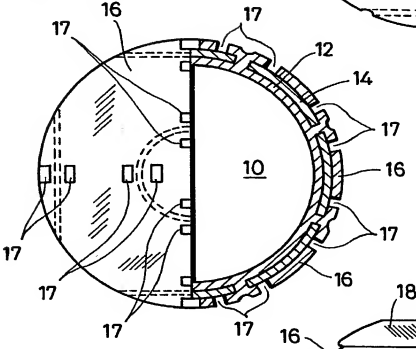


FIG. 5C

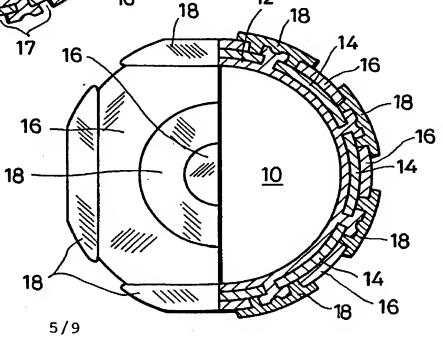


FIG. 6A

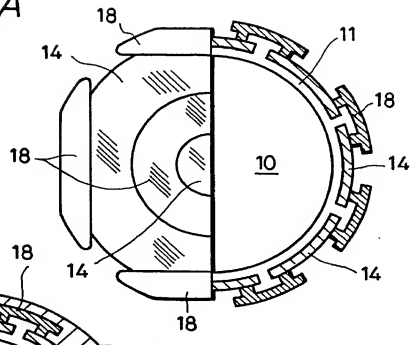


FIG. 6B

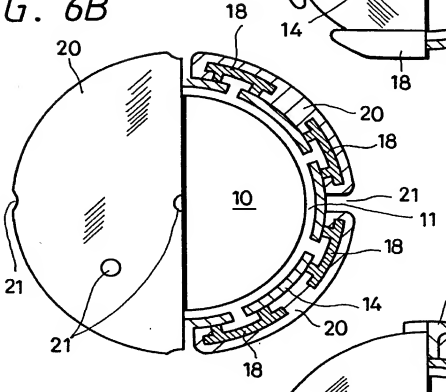


FIG. 6C

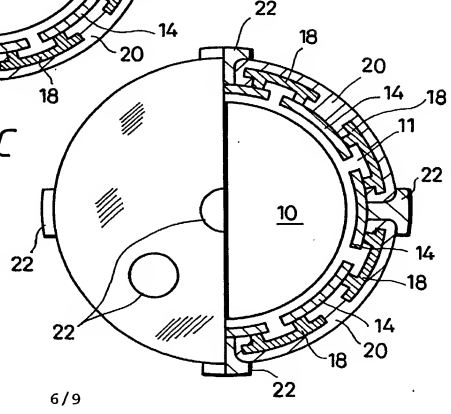
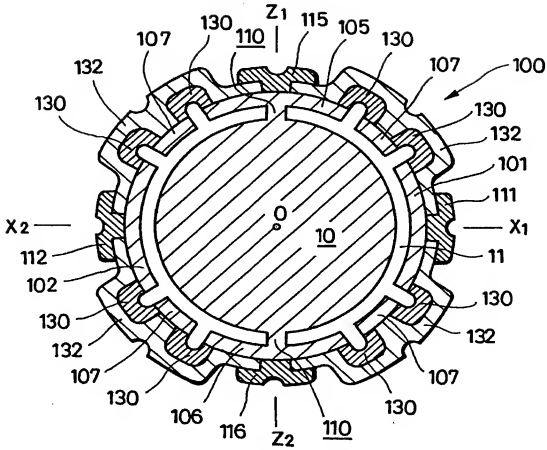


FIG. 7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100
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132
101
111
X2
O
10
X1
112
11
102
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132
132
107
107
130
130
106
116
Z2
110

FIG. 8A

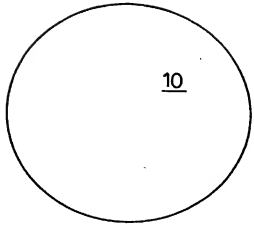


FIG. 8B

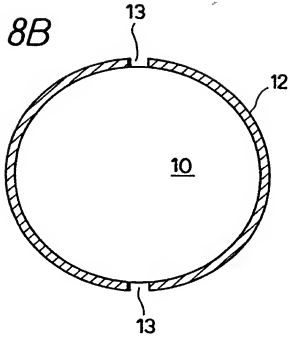
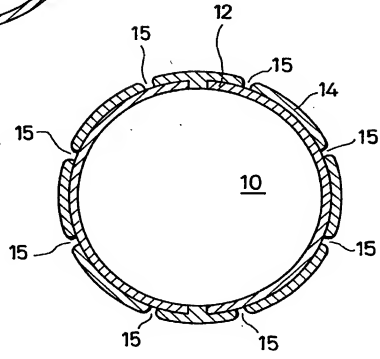


FIG. 8C



PTO/SB 106 (5-00)
Approved for use through 10/31/02 OMB 0651-0032
Patent and Trademark Office U S DEPARTMENT OF COMMERCE

Declaration and Power of Attorney for Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

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As a below named inventor, I hereby declare that:

私の住所、郵便の宛先そして国籍は、私の氏名の後に記載された通りである。

My residence, post office address and citizenship are as stated next to my name:

下記の名称の発明について、特許請求範囲に記載され、且つ特許が求められている発明主題に関して、私は、最初、最先且つ唯一の発明者である（唯一の氏名が記載されている場合）か、或いは最初、最先且つ共同発明者である（複数の氏名が記載されている場合）と信じている。

I believe I am the original, first and sole inventor if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

METHOD OF MANUFACTURING A MICROMACHINE

上記発明の明細書はここに添付されているが、下記の箱がチェックされている場合は、この限りでない：

the specification of which is attached hereto unless the following box is checked:

☐ _____ の日に出願され、
この出願の米国出願番号またはＰＣＴ国際出願番号は、
_____ であり、且つ
_____ の日に補正された出願（該当する場合）

☒ was filed on 27 April 2000
as United States Application Number of
PCT International Application Number PCT/JP00/02739
_____ and was amended on
_____ (if applicable).

私は、上記の補正書によって補正された、特許請求範囲を含む上記明細書を検討し、且つ内容を理解していることをここに表明する。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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私は、ここに、以下に記載した外国での特許出願または発明者証の出願、或いは米国以外の少なくとも一国を指定している米国法典第35編第365条(a)によるPCT国際出願について、同第119条(a)-(d)項又は第365条(b)項に基づいて優先権を主張するとともに、優先権を主張する本出願の出願日よりも前の出願日を有する外国での特許出願または発明者証の出願、或いはPCT国際出願については、いかなる出願も、下記の枠内をチェックすることにより示した。

I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT international application having a filing date before that of the application for which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed)	Priority Not Claimed 優先権主張なし
11-120260	Japan	27 April 1999	☐
PCT/JP00/02739	PCT	27 April 2000	☐
			☐
			☐
			☐
			☐

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I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application No.)
(出願番号)

(Filing Date)
(出願日)

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(Application No.)
(出願番号)

(Filing Date)
(出願日)

(Status: Patented, Pending, Abandoned)
(現況：特許許可、係属中、放棄)

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DENNIS M. SMID, Registration No. 34,930

(2)

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To the attention of: **WILLIAM S. FROMMER**

1-00

唯一または第一発明者氏名

Full name of sole or first inventor

Masayoshi ESASHI

発明者の署名　日付

inventor's signature　Date

Masayoshi Esashi　March 20, 2002

住所

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国籍

Citizenship

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full name of second joint inventor, if any

2-00

Takao MURAKOSHI

第二共同発明者の署名　日付

Second Inventor's signature　Date

Takao Murakoshi　March 18 2002

住所

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Citizenship

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Post Office Address

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16-46, Minami Kamata 2-chome
Ohta-ku, Tokyo 144-0035 Japan

（第三以下の共同発明者についても同様に記載し、署名をすること）

(Supply similar information and signature for third and subsequent joint inventors)

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書類送付先

直通電話連絡先：（氏名及び電話番号）

第三共同発明者がいる場合、その氏名

3-00

第三共同発明者の署名　　　日付

住所

国籍

郵便の宛先

第四共同発明者がいる場合、その氏名

第四共同発明者の署名　　　日付

4-20

住所

国籍

郵便の宛先

（第五以下の共同発明者についても同様に記載し、署名をすること）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact al business in the Patent and Trademark Office connected therewith (list name and registration number)

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Shigeru NAKAMURA

Third inventor's signature　　　Date

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Citizenship

Japan

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Full name of fourth joint inventor, if any

Nobuo TAKEDA

Fourth Inventor's signature　　　Date

Nobuo Takeda　　　5/20/2002

Residence

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Citizenship

Japan

Post Office Address:

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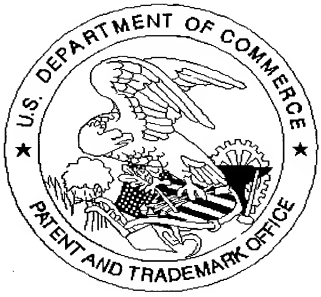
4-1-7 Minami Nagareyama
Nagareyama-shi, Chiba 270-0163 Japan

(Supply similar information and signature for fifth and subsequent joint inventors)

United States Patent & Trademark Office

Office of Initial Patent Examination -- Scanning Division



Application deficiencies found during scanning:

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☐ Page(s)_____ of _____ were not present for scanning. (Document title)

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- There are only 8 pages of Drawing, not 9.
- Page 9 of 9 of Drawing is Description of Referential 'numerals.
- Specification pages numbers out of order.